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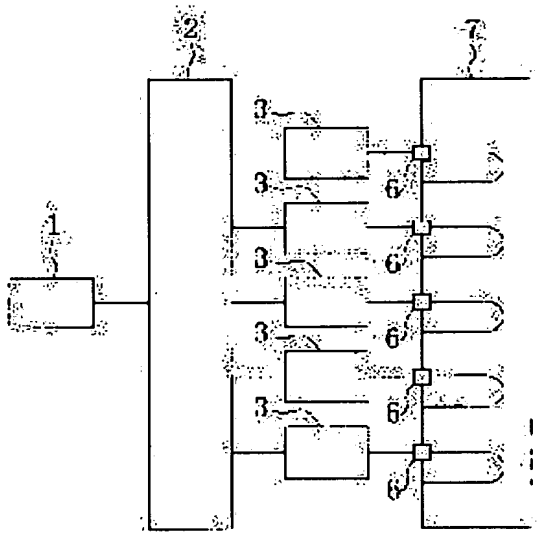
(54) POWER SOURCE SYSTEM FOR PLASMA PROCESS DEVICE

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a power source system for a plasma process device which does not necessitate extra complicated work to match, is easy to handle, reduces matching time, uniforms plasma and improves uniformity and reproducibility of thickness of film generated.
SOLUTION: In a plasma process device equipped with a plurality of U-shaped electrodes having an end for power supply and the other end for earth potential, output of a plasma generating power supply for VHF band is distributed and supplied to a plurality of power supply ends of U-shaped electrodes using a distributor from a power supply. Impedance matching with loading plasma can be abbreviated by a matching equipment or the like supplying distributed output through an isolator, and also, phases can be controlled by a phase shifter.



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* NOTICES *

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CLAIMS

[Claim(s)]
[Claim 1] The power-source system for plasma treatment equipments characterized by distributing and supplying the output of the power source for plasma generating of a VHF band to the electric supply edge of two or more of said electrodes using a distributor in plasma treatment equipment equipped with two or more U character mold electrodes whose ends are electric supply edges, and whose other ends are touch-down potential from one power source.
[Claim 2] The power-source system for plasma treatment equipments according to claim 1 characterized by linking the output of the distributed power source for plasma generating with the electric supply edge of two or more of said electrodes directly through an isolator, respectively.
[Claim 3] The power-source system for plasma treatment equipments according to claim 2 characterized by enabling adjustment of the phase of the output supplied to other electrodes on the basis of the phase of the output supplied to one electrode among the outputs of the distributed power source for plasma generating respectively.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] In the semiconductor device production process, plasma treatment processes, such as a plasma-CVD method, are applied widely. This invention relates to the power-source system for plasma treatment equipments suitable for such a plasma treatment process.
[0002]
[Description of the Prior Art] In the field of semiconductor device manufacture, it is in the inclination of large-area-izing of a device, and high integration, and the plasma generating technique of high density and the diameter of size ** is demanded under the low voltage force as a source of the plasma used for it in recent years.
[0003] For example, with the plasma-CVD equipment which forms the amorphous silicon thin film used for a solar battery, a thin film transistor, etc., in order to realize plasma discharge of a large area, this invention persons proposed the method which prepares two or more U character mold electrodes in a vacuum housing previously (application for patent 2000 1 056584). the plasma-treatment equipment of an internal electrode method equipped with the electrode of the inductive-coupling mold with which this plasma-CVD equipment has been arranged in a vacuum housing -- it is -- an electrode -- a line -- it has the gestalt of the U character mold which turned up the conductor in that center section and was formed, a RF supplies to the edge of this electrode and discharge makes around an electrode so that the standing wave of the half-wave length may stand on the part which that electrode turned up and was formed, and it is constituted so that the plasma may generate.

[0004] In this case, the frequency of the RF supplied to an electrode is decided by relation with the die length of the U character mold electrode concerned, and in **, in order to generate ** and the uniform plasma, the RF of a VHF band 60MHz or more higher than the usual RF (for example, 13.56MHz) used from the former is adopted.
[0005] As shown in drawing 5 , in order to supply the output of RF generator 1 to each of the electric supply edge 6 of two or more U character mold electrodes with which the plasma production room 7 was equipped as a current supply system in this plasma-CVD equipment, the combination of the RF generator 1 and the adjustment machine 3 of the number of an electrode and the same number is usually arranged.
[0006]
[Problem(s) to be Solved by the Invention] However, since only the number of the electrodes which the set of an RF generator and an adjustment machine uses is needed in the above-mentioned current supply system, it is very expensive in ** cost. ** In order to arrange the set of many RF generators and an adjustment machine, a large tooth space is required. Since it is usually desirable about especially an adjustment machine to arrange [of an electric supply edge] to near as much as possible, the configuration around a plasma production room becomes complicated. ** Control becomes complicated on operation of equipment. ** There is a problem of ** that the maintenance of equipment is serious.
[0007] Moreover, since the number of RF generators increases and it cannot arrange near the electric supply edge, and it becomes the configuration that the distance from each RF generator to an electric supply edge became independent and the electrical-potential-difference phase of the high frequency impressed to a U character each mold electrode becomes scatteringly, the stability of ** plasma and homogeneity worsen. ** Also produce problems, like distribution of the thickness of the formed thin film worsens.

[0008] This invention solves the above-mentioned trouble, the complicated time and effort which takes adjustment is not required, but handling is easy, and adjustment time amount is shortened, and it aims at the plasma offering the power-source system for plasma treatment equipments which becomes homogeneity and can aim at improvement in the homogeneity of the thickness to generate, and repeatability.
[0009] Especially this invention aims at offering the suitable power-source system for the plasma treatment equipment of the method which prepares two or more U character mold electrodes proposed at said this invention persons' point.
[0010]
[Means for Solving the Problem] This invention for attaining the above-mentioned purpose is a power-source system for plasma treatment equipments characterized by distributing and supplying the output of the power source for plasma generating of a VHF band to the electric supply edge of two or more of said electrodes using a distributor from one power source in plasma treatment equipment equipped with two or more U character mold electrodes whose ends are electric supply edges and whose other ends are touch-down potential.
[0011] In the power-source system for plasma treatment equipments by above-mentioned this invention, it is combinable with the electric supply edge of two or more electrodes of a direct plasma production room through an isolator instead of an adjustment machine etc. performing impedance matching with the load plasma, after a distributor distributes the output of a VHF band RF generator to plurality.
[0012] Moreover, in this invention, adjustment of the phase of the output supplied to other electrodes on the basis of the phase of the output supplied to one electrode among the outputs of said distributed power source for plasma generating can be enabled respectively. That is, supervising the situation of plasma generating of the phase of the electrical potential difference concerning the electrode of the plasma production interior of a room, or the formed thickness distribution, an adjustable setup can be carried out at arbitration so that it may be in the optimal condition.
[0013] In plasma treatment equipment equipped with two or more U character mold electrodes whose ends synthesize the above and are electric supply edges and whose other ends are touch-down potential according to this invention From one power source, using a distributor, distribute the output of the power source for plasma generating of a VHF band to said two or more electrodes, and it is supplied. The output of the distributed power source for plasma generating is directly linked with the electric supply edge of two or more of said electrodes through an isolator, respectively. Furthermore, it is based on the phase of the output which inserts a phase shifter, for example between a distributor and each isolator, and is supplied to one electrode among the outputs of the distributed power source for plasma generating. The power-source system for plasma treatment equipments characterized by enabling respectively adjustment of the phase of the output supplied to other electrodes is offered.
[0014]
[Embodiment of the Invention] Below, the gestalt of operation of the power-source system for plasma treatment equipments by this invention is explained using a drawing. Drawing 1 is one example of the schematic diagram of the power-source system by this invention which distributed the output of one RF generator to five U character mold electrodes using the distributor. In drawing 1 , 1 is an RF generator. In this example of illustration, in order to find the optimal frequency with the configuration of an electrode, the frequency was made into the adjustable method and set to 85MHz**10MHz. An output is 3kW.
[0015] 2 is a distributor and is a system which distributes equally the RF output generated with the power source 1 for plasma generating to two or more electrodes 6 in the plasma production room 7 (output terminal). Although the example of illustration showed the example distributed to five electrodes, for example, there is an example distributed to 16 electrodes. [still] In this invention, the distributor by the quarter-wave length having-consistency method of a coaxial tube was adopted in consideration of the cost-thing. 3 is an adjustment machine and is the same as the adjustment machine in the case of using by the power-source system equipped with two or more power sources of the method shown in drawing 5 .
[0016] It is that the VSWR property of that there is little deflection of the rate of ** partition ratio, that there are few ** insertion losses, a thing with little (the isolation between output terminals is large) interference during ** output, and ** input terminal is good as a function demanded as a distributor used for a RF circuit, that ** configuration is small, etc.
[0017] As a method of a distributor, there are a resistance distributor, T junction, a hybrid distributor, a

Wilkinson mold distributor, etc. There is a distributor using only the resistor as easiest approach. Although there is an advantage that this is easy to design, and can carry out [broadband]-izing of it, and its magnitude also settles with magnitude extent of a resistor, there is a fault of not satisfying the property of above ** and **. That is, an insertion loss is large, and since there is a trouble with a VHF band that isolation between output terminals cannot be taken, that the frequency characteristics of a resistor are not still better, etc., it is seldom used in the RF circuit of an actual VHF band.

[0018] As two distributors, a hybrid circuit (distributor) is used well. It is the features that this can take the isolation between output terminals. The directional coupler and output whose phase contrast of an output is 90 degrees have Rat Race of an inphase etc. in a hybrid circuit. as the structure which constitutes these -- a UHF band -- distributed constant tracks (quarter-wave length etc.) -- moreover, the toroidal core of a ferrite etc. is used with the VHF band. Although there is also the approach of making multistage connection of the two distributors as a method of a distributor, it is a difficulty that a configuration becomes large.

[0019] Although a Wilkinson mold distributor is the distributing system which was suitable when there were many distribution numbers, in order to take the isolation between output terminals, the resistance for isolation is needed between branch line ways. The method used by this invention is not a Wilkinson mold but a T junction method. Although a T junction method is easy structure since it carries out equipartition of the output terminal suddenly, the isolation between output terminals cannot be taken. However, it is because the isolation between output terminals can be taken when an isolator and a circulator are in a load side, so it is convenient using T junction.

[0020] The conceptual diagram of this distributor is shown in drawing 2 . Drawing 2 is what showed the example of the distributor which used the quarter-wave line, and, as for 8, as for a quarter-wave line and 10, the input terminal of a distributor and 9 are the output terminals of a distributor (the case where the number of output terminals is five is illustrated). Setting load impedance to R1, W, then its input impedance are the characteristic impedance of a quarter-wave line 9 R1/W2 It is expressed. That is, a quarter-wave line has an impedance reversal operation.

[0021] Therefore, the number of output terminals is set to N, and R1, then characteristic-impedance W of a quarter-wave line choose source impedance with Rg, and should just choose load impedance with root (Rg-R1/N). In a multistage case, a quarter-wave line may be further established in that input side in fact due to the ease of realizing of characteristic-impedance W of this quarter-wave line.

[0022] When a coaxial track is used as a quarter-wave line, the adjustment for taking adjustment, since it is decided by the mechanical dimension so to speak when it is decided by the ratio with the bore of a conductor outside among the coaxial tube that the characteristic-impedance W will be the outer diameter of a conductor becomes unnecessary, and is very easy. If one frequency is sufficient as an operating frequency like [in usual], one step is sufficient as the number of stages of the quarter-wave length of this transmission line, but when 85**10MHz and a band have a large frequency, in order to improve frequency characteristics, the quarter-wave line was made into two steps, and adjustment is taken.

[0023] Drawing 3 is a schematic diagram at the time of supplying the output of the RF generator distributed to five to the electric supply edge of the electrode of a direct plasma production room through an isolator 4 as one example of the power-source system by this invention, respectively with the distributor of drawing 1 . If an isolator 4 is used instead of the adjustment machine 3 of drawing 1 , by fluctuation of the load plasma, the time and effort which it omits an adjustment machine since the output of an RF generator can prevent the problem that actuation of plasma treatment becomes unstable, in response to effect, and takes adjustment will be saved, and time amount compaction will be achieved. Moreover, since there is no power loss in an adjustment machine, a power outlet will be efficiently supplied to an electrode.

[0024] Drawing 4 is the power-source system tree which carried out additional insertion of the phase shifter 5 further between the distributor 2 and the isolator 4 in the power-source system shown in drawing 3 as one example of the power-source system by this invention. In the power-source system of drawing 4 , since the phase of the output supplied to other electrodes on the basis of the phase of the output supplied to one electrode can be adjusted in the output of the distributed power source for plasma generating using a phase shifter 5, respectively and generating of the plasma becomes homogeneity, the homogeneity of thickness and repeatability which are processed can be raised.

[0025]

[Effect of the Invention] Handling became easy while need cost decreased compared with the conventional method which has arranged many power sources in the power-source system for plasma treatment equipments by distributing the output of a VHF band RF generator to plurality using a distributor from one power source according to this invention, as explained above.
[0026] Moreover, since plasma treatment is possible regardless of the time amount taken to have omitted adjustment equipment, to have lost the complicated time and effort which will take adjustment if the power-source system which supplies the output of an RF generator to a direct electrode through an isolator is taken, and to be able to take adjustment, time amount is shortened, and since the amount of power loss within an adjustment machine is not further, the output of an RF generator comes to be efficiently supplied in the plasma.
[0027] If the power-source system which furthermore inserts a phase shifter etc. between a distributor and an isolator is taken, it will become possible to become homogeneity and to raise the homogeneity of thickness and repeatability by which plasma treatment is carried out of generating of the plasma by having enabled it to control the phase of the RF supplied to each electrode.
[0028] Especially this invention does very remarkable effectiveness so by applying to the plasma treatment equipment of the method with which this invention persons prepare two or more U character mold electrodes invented previously.

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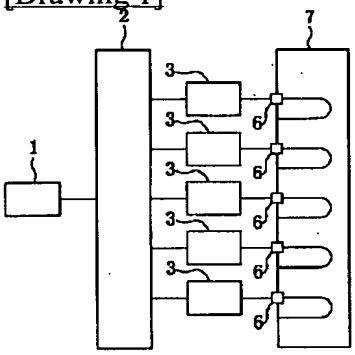
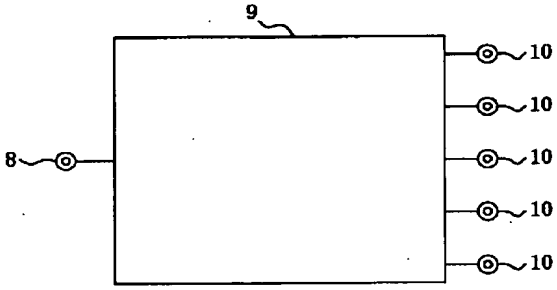
DRAWINGS

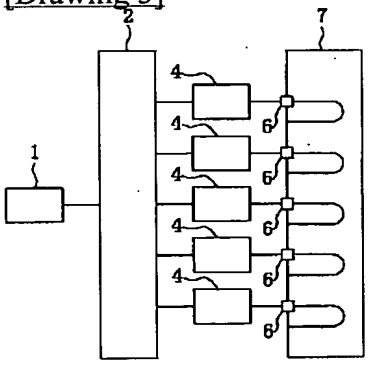
[Drawing 1]



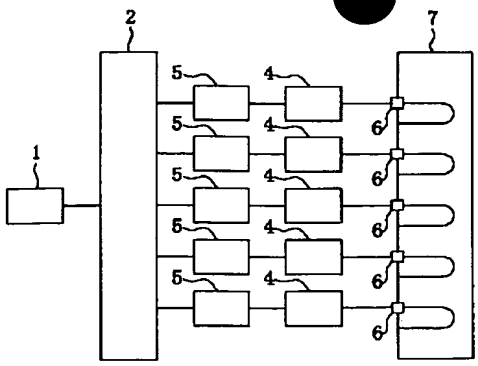
[Drawing 2]



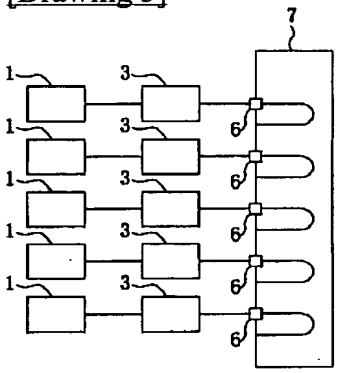
[Drawing 3]



[Drawing 4]



[Drawing 5]



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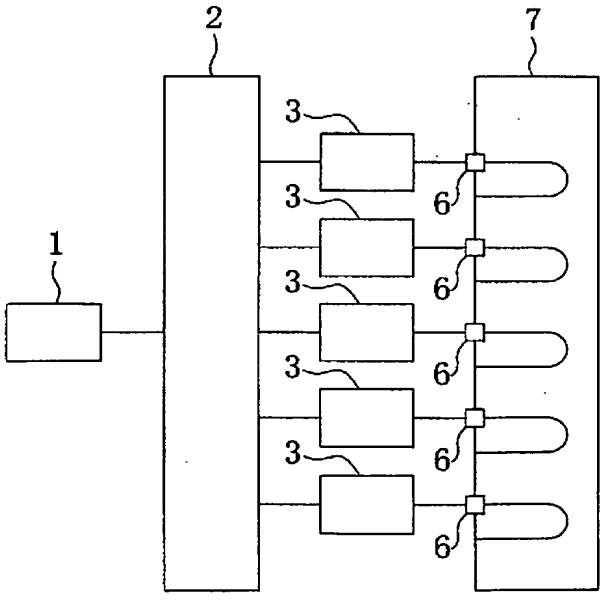
EH04 EH11

(54)【発明の名称】プラズマ処理装置用電源システム

(57)【要約】
【課題】　整合をとる煩雑な手間を要せず、取り扱いが容易で整合時間が短縮され、かつプラズマが均一になり、生成する膜厚の均一性及び再現性の向上を図ることができるプラズマ処理装置用電源システムを提供する。
【解決手段】　一端が給電端であり他端が接地電位であるＵ字型電極を複数備えたプラズマ処理装置において、ＶＨＦ帯域のプラズマ発生用電源の出力を、１つの電源から分配器を用いて複数のＵ字型電極の給電端に分配して供給する。分配された出力をアイソレーターを介して供給すれば、整合器等で負荷プラズマとのインピーダンス整合を省略することができ、また、移相器等により位相を制御することもできる。



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【特許請求の範囲】

【請求項１】　一端が給電端であり他端が接地電位であるＵ字型電極を複数備えたプラズマ処理装置において、ＶＨＦ帯域のプラズマ発生用電源の出力を、１つの電源から分配器を用いて前記複数の電極の給電端に分配して供給することを特徴とするプラズマ処理装置用電源システム。

【請求項２】　分配されたプラズマ発生用電源の出力を、それぞれアイソレーターを介して前記複数の電極の給電端に直結したことを特徴とする請求項１記載のプラズマ処理装置用電源システム。

【請求項３】　分配されたプラズマ発生用電源の出力のうち、一つの電極に供給される出力の位相を基準として、他の電極に供給される出力の位相をそれぞれ調整可能にしたことを特徴とする請求項２記載のプラズマ処理装置用電源システム。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】半導体デバイス製造工程の中では、プラズマＣＶＤ法等のプラズマ処理プロセスが広く応用されている。本発明はこのようなプラズマ処理プロセスに適したプラズマ処理装置用電源システムに関する。

【０００２】

【従来の技術】近年半導体デバイス製造の分野では、デバイスの大面積化、かつ高集積化の傾向にあり、それに用いられるプラズマ源として、低圧力下で高密度・大口径のプラズマ発生技術が要求されている。

【０００３】例えば、太陽電池や薄膜トランジスタなどに利用されるアモルファスシリコン薄膜を形成するプラズマＣＶＤ装置では、大面積のプラズマ放電を実現するために、本発明者らは先に真空容器内に複数のＵ字型電極を設ける方式を提案した（特願２０００－０５６５８４）。このプラズマＣＶＤ装置は、真空容器内に配置された誘導結合型の電極を備える内部電極方式のプラズマ処理装置であって、電極は線状導体をその中央部で折り返して形成されたＵ字型の形態を有し、その電極の折り返して形成された部分に半波長の定在波が立つようにこの電極の端部に高周波を供給して電極の周囲に放電を作り、プラズマを生成するように構成されている。

【０００４】この場合、電極に供給される高周波の周波数は、当該Ｕ字型電極の長さとの関係で決められてをり、均一なプラズマを生成するために、従来から利用されていた通常の高周波（例えば１３．５６ＭＨｚ）よりも高い６０ＭＨｚ以上のＶＨＦ帯の高周波が採用されている。

【０００５】このプラズマＣＶＤ装置における電源供給システムとしては、図５に示すように、プラズマ生成室７に備えた複数のＵ字型電極の給電端６のそれぞれに高周波電源１の出力を供給するために、通常は電極の個数

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と同数の、高周波電源１及び整合器３の組み合わせを配置している。

【０００６】

【発明が解決しようとする課題】しかしながら、上記の電源供給システムでは、高周波電源及び整合器のセットが、使用する電極の数だけ必要となるため、①コスト的に非常に高価である。②沢山の高周波電源と整合器のセットを配置するため広いスペースが必要である。特に整合器については、通常給電端の出来るだけ近くに配置するのが望ましいので，プラズマ生成室の周囲の構成が複雑になる。③装置の運転上、制御が複雑になる。④装置のメインテナンスが大変である、等の問題がある。

【０００７】また高周波電源の数が多くなるため、給電端の近傍に配置できないので、各高周波電源から給電端までの距離が独立した構成となり、各Ｕ字型電極に印加される高周波の電圧位相がバラバラとなるため、⑤プラズマの安定性、均一性が悪くなる。⑥形成された薄膜の膜厚の分布が悪くなる、などの問題も生ずる。

【０００８】本発明は上記の問題点を解決し、整合をとる煩雑な手間を要せず、取り扱いが容易で整合時間が短縮され、かつプラズマが均一になり、生成する膜厚の均一性及び再現性の向上を図ることができるプラズマ処理装置用の電源システムを提供することを目的とする。

【０００９】本発明は特に前記本発明者らの先に提案した複数のＵ字型電極を設ける方式のプラズマ処理装置に好適な電源システムを提供することを目的とする。

【００１０】

【課題を解決するための手段】上記の目的を達成するための本発明は、一端が給電端であり他端が接地電位であるＵ字型電極を複数備えたプラズマ処理装置において、ＶＨＦ帯域のプラズマ発生用電源の出力を、１つの電源から分配器を用いて前記複数の電極の給電端に分配して供給することを特徴とするプラズマ処理装置用の電源システムである。

【００１１】上記本発明によるプラズマ処理装置用の電源システムにおいては、ＶＨＦ帯高周波電源の出力を分配器で複数に分配した後、整合器等で負荷プラズマとのインピーダンス整合を行なう代わりに、アイソレーターを介して直接プラズマ生成室の複数の電極の給電端に結合することができる。

【００１２】また本発明においては、前記分配されたプラズマ発生用電源の出力のうち、一つの電極に供給される出力の位相を基準として、他の電極に供給される出力の位相をそれぞれ調整可能にすることができる。すなわち、プラズマ生成室内の電極にかかる電圧の位相を、プラズマ発生の状況あるいは形成された膜厚分布等を監視しながら、最適の状態になるように、任意に可変設定することができる。

【００１３】本発明によれば、上記を総合し、一端が給電端であり他端が接地電位であるＵ字型電極を複数備え

たプラズマ処理装置において、ＶＨＦ帯域のプラズマ発生用電源の出力を、１つの電源から分配器を用いて前記複数の電極に分配して供給し、その分配されたプラズマ発生用電源の出力を、それぞれアイソレーターを介して前記複数の電極の給電端に直結し、さらに、例えば分配器と各アイソレーターとの間に移相器を挿入し、分配されたプラズマ発生用電源の出力のうち、一つの電極に供給される出力の位相を基準として、他の電極に供給される出力の位相をそれぞれ調整可能にしたことを特徴とするプラズマ処理装置用の電源システムを提供する。

【００１４】

【発明の実施の形態】以下に、本発明によるプラズマ処理装置用の電源システムの実施の形態について図面を用いて説明する。図１は、１つの高周波電源の出力を、分配器を用いて５つのＵ字型電極に分配した本発明による電源システムの系統図の１例である。図１において、１は高周波電源である。本図示例では電極の形状により最適な周波数を見つけるため、周波数は可変方式とし８５ＭＨｚ±１０ＭＨｚとした。出力は３ＫＷである。

【００１５】２は分配器で、プラズマ発生用電源１で発生した高周波出力をプラズマ生成室７内の複数の電極（出力端子）６に均等に分配するシステムである。図示例は５個の電極に分配する例を示したが、さらに多く、例えば１６個の電極に分配する実施例などもある。本発明では、コスト的な事を考慮し、同軸管の１／４波長整合法による分配器を採用した。３は整合器で、図５に示した方式の複数の電源を備えた電源システムで用いる場合の整合器と同じものである。

【００１６】高周波回路に用いる分配器として要求される機能としては、①分配比率の偏差が少ないこと、②挿入損失が少ないこと、③出力間の干渉が少ない（出力端子間のアイソレーションが大きい）こと、④入力端子のＶＳＷＲ特性が良いこと、および⑤形状が小さいこと、などである。

【００１７】分配器の方式としては、抵抗分配器、Ｔ分岐、ハイブリッド分配器、ならびにＷｉｌｋｉｎｓｏｎ型分配器などがある。最も簡単な方法としては抵抗器だけを用いた分配器がある。これは設計が容易で広帯域化でき、大きさも抵抗体の大きさ程度でまとまるという利点はあるが、上記の②および③の特性を満足しないという欠点がある。すなわち、挿入損失が大きく、また出力端子間のアイソレーションがとれない、さらに抵抗器の周波数特性がＶＨＦ帯では良好でないなどの問題点があるために実際のＶＨＦ帯の高周波回路ではあまり使用されない。

【００１８】２分配器としてはハイブリッド回路（分配器）がよく用いられる。これは出力端子間のアイソレーションがとれることが特長である。ハイブリッド回路には出力の位相差が９０°の方向性結合器や出力が同相のラットレースなどがある。これらを構成する構造としてＵＨＦ帯では分布定数線路（１／４波長などの）が、またＶＨＦ帯ではフェライトのトロイダルコアなどが使用されている。分配器の方式として２分配器を多段接続する方法もあるが、形状が大きくなるのが難点である。

【００１９】Ｗｉｌｋｉｎｓｏｎ型分配器は分配数の多い場合に適した分配方式であるが、出力端子間のアイソレーションをとるために分岐線路間にアイソレーション用抵抗が必要になる。本発明で使用する方式はＷｉｌｋｉｎｓｏｎ型ではなくＴ分岐方式である。Ｔ分岐方式は出力端子をいきなり等分配するので構造が簡単であるが、出力端子間のアイソレーションはとれない。しかし、負荷側にアイソレータやサーキュレータがある場合は出力端子間のアイソレーションがとれるのでＴ分岐を使用するには都合が良いからである。

【００２０】この分配器の概念図を図２に示す。図２は１／４波長線路を用いた分配器の例を示したもので、８は分配器の入力端子、９が１／４波長線路、１０は分配器の出力端子である（出力端子が５つの場合を例示）。負荷インピーダンスをＲ１とし、１／４波長線路９の特性インピーダンスをＷとすれば、その入力インピーダンスは$R1/W^2$　で表される。つまり１／４波長線路はインピーダンス反転作用がある。

【００２１】したがって出力端子数をＮとし、電源インピーダンスをＲｇ、負荷インピーダンスをＲ１とすれば、１／４波長線路の特性インピーダンスＷは$\sqrt{}$（Ｒｇ・Ｒ１／Ｎ）と選べばよい。実際には多段の場合はこの１／４波長線路の特性インピーダンスＷの実現し易さの関係でその入力側にさらに１／４波長線路を設けることもある。

【００２２】１／４波長線路として同軸線路を用いた場合は、その特性インピーダンスＷはその同軸管の内導体の外径と外導体の内径との比率で決まる、いわば機械的寸法で決まるので、整合をとるための調整等は不要になり非常に簡単である。通常の場合のように使用周波数が１周波数でよいならこの伝送線路の１／４波長の段数は１段でよいが、周波数が８５±１０ＭＨｚと帯域が広い場合は、周波数特性を改善するために１／４波長線路を２段にして整合をとっている。

【００２３】図３は、本発明による電源システムの１例として、図１の分配器によって５つに分配された高周波電源の出力を、それぞれアイソレーター４を介して直接プラズマ生成室の電極の給電端へ供給した場合の系統図である。アイソレーター４を図１の整合器３の代わりに使用すれば、負荷プラズマの変動により高周波電源の出力が影響を受けてプラズマ処理の動作が不安定になるという問題を防止することができるので、整合器を省略して整合をとる手間が省かれ、時間短縮が図られる。また、整合器内における電力損失がないから、電源出力が効率的に電極に供給されることになる。

【００２４】図４は、さらに本発明による電源システム

の１例として、図３に示した電源システムにおいて、分配器２とアイソレーター４の間にさらに移相器５を追加挿入した電源システム系統図である。図４の電源システムでは、分配されたプラズマ発生用電源の出力の中、一つの電極に供給される出力の位相を基準として、他の電極に供給される出力の位相を移相器５を用いてそれぞれ調整することができ、プラズマの発生が均一になるので、処理される膜厚の均一性及び再現性を向上させることができる。

【００２５】

【発明の効果】以上説明したように、本発明によれば、プラズマ処理装置用の電源システムにおいて、ＶＨＦ帯高周波電源の出力を一つの電源から分配器を用いて複数に分配することにより、沢山の電源を配置した従来の方式に比べて必要コストが少なくなると共に、取り扱いが容易になった。

【００２６】また整合装置を省略し、アイソレーターを介して直接電極に高周波電源の出力を供給する電源システムを採れば、整合をとる煩雑な手間がなくなり、整合がとれるまでに要した時間に関係なくプラズマ処理ができるので、時間が短縮され、さらに整合器内での電力損失分がないので、高周波電源の出力が効率良くプラズマ内に供給されるようになる。

【００２７】さらに分配器とアイソレーターの間に移相器等を挿入する電源システムを採れば、各電極に供給される高周波の位相を制御できるようにしたことにより、プラズマの発生が均一になり、プラズマ処理される膜厚の均一性及び再現性を向上させることが可能となる。

【００２８】本発明は特に、本発明者らが先に発明した複数のＵ字型電極を設ける方式のプラズマ処理装置に適用することにより極めて顕著な効果を奏するものである。

【図面の簡単な説明】

【図１】本発明によるプラズマ処理装置用電源システムの１例を示す系統図

【図２】１／４波長線路を用いた分配器の概念図

【図３】図１において、アイソレーターを介して直接給電した場合の例

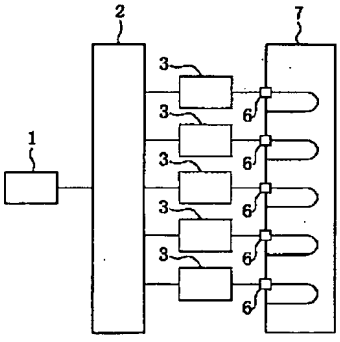
【図４】図２において、移相器を連結した場合の例

【図５】従来方式のプラズマ処理装置用電源システムの系統図

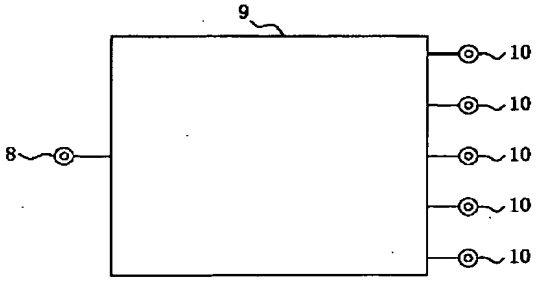
【符号の説明】

１　高周波電源
２　分配器
３　整合器
４　アイソレーター
５　移相器
６　給電端
７　プラズマ生成室
８　分配器の入力端子
９　１／４波長線路
１０　分配器の出力端子

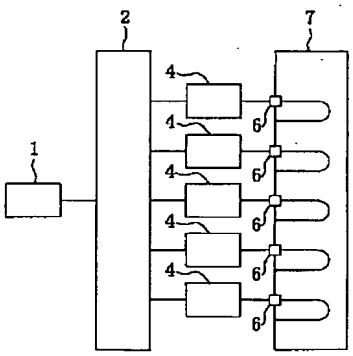
【図１】



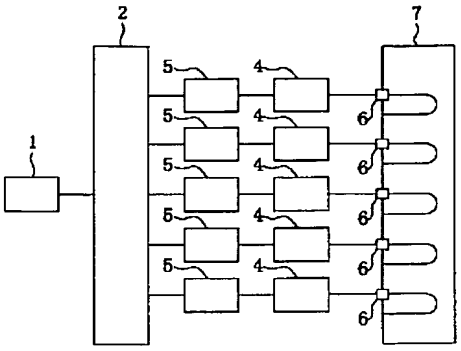
【図２】



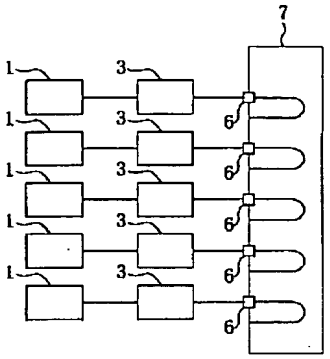
【図３】



【図４】



【図５】



【手続補正書】
【提出日】平成１３年１０月１６日（２００１．１０．１６）
【手続補正１】
【補正対象書類名】明細書
【補正対象項目名】０００３
【補正方法】変更
【補正内容】
【０００３】例えば、太陽電池や薄膜トランジスタなどに利用されるアモルファスシリコン薄膜を形成するプラズマＣＶＤ装置では、大面積のプラズマ放電を実現するために、真空容器内に複数のＵ字型電極を設ける方式が提案されている。このプラズマＣＶＤ装置は、真空容器内に配置された誘導結合型の電極を備える内部電極方式のプラズマ処理装置であって、電極は線状導体をその中央部で折り返して形成されたＵ字型の形態を有し、その電極の折り返して形成された部分に半波長の定在波が立つようにこの電極の端部に高周波を供給して電極の周囲に放電を作り、プラズマを生成するように構成されている。
【手続補正２】
【補正対象書類名】明細書
【補正対象項目名】０００９
【補正方法】変更
【補正内容】
【０００９】本発明は、複数のＵ字型電極を設ける方式のプラズマ処理装置に好適な電源システムを提供することを目的とする。
【手続補正３】
【補正対象書類名】明細書
【補正対象項目名】００２８
【補正方法】変更
【補正内容】
【００２８】本発明は、複数のＵ字型電極を設ける方式のプラズマ処理装置に適用することにより極めて顕著な効果を奏するものである。

PATENT ABSTRACTS OF JAPAN

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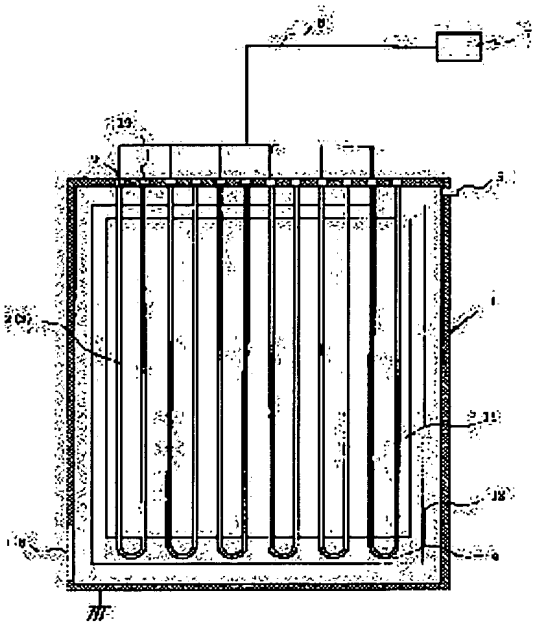
(54) DISCHARGE DEVICE, PLASMA TREATMENT METHOD AND SOLAR CELL

(57)Abstract:
PROBLEM TO BE SOLVED: To provide novel antenna structure and power supply method for causing generation of a standing wave to substantially disappear, to provide a discharge device having high plasma evenness, a plasma treatment method of a large-surface substrate and a solar cell having high productivity.
SOLUTION: A plurality of U-shaped antenna elements, both ends of which are used as a power supply end and an earth end, respectively, are arranged with equal intervals on a plane in such a manner that the earth end and the power supply end alternate to construct an array antenna, a phase is changed 180° in order from the end of the power supply end to supply AC power of the same frequency at a time, the length of a linear conductor is determined at the frequency of 10 MHz-2 GHz in such a manner that the ratio of a reflected wave measured at the power supply end to a progressive wave measured at the power supply end is 0.1 or lower. When α is regarded as a subtrahend constant, the length La (m) of the linear conductor is controlled to $0.5(1/\alpha)<La<10(1/\alpha)$.



LEGAL STATUS

[Date of request for examination]

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[Date of final disposal for application]

[Patent number]

[Date of registration]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The lot of the edge which adjoins each other among edges is combined electrically. the shape of first [with two equal die length], and second straight line -- a conductor -- parallel -- arranging -- the shape of said first and second straight line -- a conductor -- the shape of first straight line -- the end of the side with which a conductor is not combined -- a touch-down edge -- carrying out -- the shape of second straight line -- the antenna element which used the end of the side with which a conductor is not combined as the electric power supply edge which can apply alternating current power two or more the shape of a straight line of each antenna element -- so that a conductor may become parallel and a touch-down edge and an electric power supply edge may serve as alternation In the discharge device which arranges at equal intervals on the first [in a vacuum] flat surface, constitutes array antennas, supplies alternating current power to these array antennas, and forms the discharge plasma into a vacuum That of an electric power supply edge changes 180 degrees of phases at a time in direct order, and it is characterized [first] by supplying electric power in the alternating current power of the same frequency all at once. it is characterized [second] by setting this frequency to 10MHz - 2GHz, and 0.1 or less are the ratio of the reflected wave to the progressive wave measured at an electric power supply edge -- as -- the shape of a straight line -- the discharge device characterized [third] by defining the die length of a conductor.
[Claim 2] The lot of the edge which adjoins each other among edges is combined electrically. the shape of first [with two equal die length], and second straight line -- a conductor -- parallel -- arranging -- the shape of said first and second straight line -- a conductor -- the shape of first straight line -- the end of the side with which a conductor is not combined -- a touch-down edge -- carrying out -- the shape of second straight line -- the antenna element which used the end of the side with which a conductor is not combined as the electric power supply edge which can apply alternating current power two or more the shape of a straight line of each antenna element -- so that a conductor may become parallel and a touch-down edge and an electric power supply edge may serve as alternation In the discharge device which arranges at equal intervals on the first [in a vacuum] flat surface, constitutes array antennas, supplies alternating current power to these array antennas, and forms the discharge plasma into a vacuum It is characterized [first] by for that of a power electric supply edge changing 180 degrees of phases at a time, and supplying electric power in the alternating current power of the same frequency all at once in direct order. It is characterized [second] by setting this frequency f (Hz) to 10MHz - 400MHz, and a frequency f and said discharge pressure p (Pa) are used for dielectric constant kappap of the plasma,

$$\kappa_p = 1 - \frac{\frac{1.61\times10^{17}}{f^2}}{1 - j1.54\left(\frac{p}{f}\right)\times10^{7}}$$

Skin depth [of the electromagnetic field which come out, express and invade into the plasma further] delta (m)

$$\delta = -210 f \times 10^{-8}\,\mathrm{Im}\left[\sqrt{\kappa_p}\right]$$

The attenuation coefficient alpha which comes out, and is calculated when expressed (1/m)